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More Affordable Seawater Desalination

Technological advances are expected to drive down the costs of seawater desalination.

By Nikolay Voutchkov

The world's oceans contain over 97.2 percent of the planet's water resources. Because of the high salinity of ocean water and the significant costs associated with seawater desalination, most of the world population's water supply has traditionally come from fresh water sources—groundwater aquifers, rivers, and lakes. However, changing climate patterns combined with population growth pressures and limited availability of new and inexpensive fresh water supplies are shifting the water industry's attention to an emerging trend—the world is reaching to the ocean for fresh water.

The ocean has two unique and distinctive features as a water supply source: it is drought proof and it is practically limitless. Over 50 percent of the world's population lives in urban centers bordering an ocean or sea. Usually coastal zones are the highest population growth hot spots as well. Therefore, seawater desalination provides the logical solution for a sustainable, long-term management of the growing water demand pressures in coastal areas.

Until recently, seawater desalination has been limited to the desert-climate dominated regions of the world. New technological advances and associated decreases in water production costs over the past decade have expanded its use into coastal areas traditionally supplied with fresh water resources. Recent examples are the 86-mgd Ashkelon Seawater Desalination Plant in Israel, and the 36-mgd Tuas Plant in Singapore. Both plants began operation in the second half of 2005 and currently produce high quality water for potable, agricultural, and industrial uses at a price of \$1.99/1,000 gal and \$1.82/1,000 gal, respectively.

Reverse osmosis membranes-the work horses of today's desalination plants.

Membrane seawater desalination is becoming more affordable in the U. S. as well. The cost of desalinated water produced at the Tampa Bay seawater desalination plant in Florida is estimated at \$2.45/1,000 gal. The cost of desalinated water offered to the City of Carlsbad and neighboring communities in San Diego County is in a range of \$2.70 to \$2.80/1,000 gal. With a credit of \$0.77/1,000 gal, which will be awarded to local utilities by the Municipal Water District of Southern California, the cost of desalinated water will match that currently paid by most utilities for alternative drinking water supplies.

Today, desalination plants provide about one percent of the world's drinking water and this percentage is increasing annually. Over \$10 billion of investment in the next five years would yield an additional 1,500 mgd of new desalinated water production capacity. This capacity is expected to double by 2015.

Two basic types of technologies have been widely used to separate salts from ocean water: thermal evaporation and membrane separation. In the last ten years, seawater desalination using semipermeable seawater reverse osmosis (SWRO) membranes have gained momentum and they currently dominate desalination markets, outside of the Middle Eastern region where thermal evaporation is still the desalination technology of choice mainly due to access to lower-cost fuel and traditional use of facilities co-generating power and water.

Membrane Technology and Cost Trends

Developments in SWRO desalination technology during the past two decades, combined with transition to construction of large capacity plants, colocation with power plant generation facilities, and enhanced competition by using the Build-Own-Operate-Transfer method of project delivery, have resulted in a dramatic decrease in the cost of desalinated water.

One of the key factors that contributed to the dramatic decrease of cost of seawater desalination is the advancement of SWRO membrane technology. Today's high-productivity membrane elements are designed with features to yield more fresh water per membrane element. These features are: 1) higher surface area and 2) denser membrane packing. Increasing active membrane leaf surface area allows significant productivity gains using the same size (diameter) membrane element. Active surface area of the membrane leaf is typically increased by improving and automating the membrane production process.

The total active surface area in a membrane element can also be increased by increasing membrane size/diameter. Although eight-in. SWRO membrane elements are still a standard size for most large full-scale applications, larger 16-in. and 18-in. membrane elements are currently commercially available. In the second half of the 1990s the typical eight-in. SWRO membrane element had a standard productivity of 5,000 to 6,000 gpd at salt rejection of 99.6 percent. In 2003, several membrane manufacturers introduced high-productivity seawater membrane elements that can produce 7,500 gpd at salt rejection of 99.75 percent. Just one year later, even higher productivity (9,000 gpd at 99.7 percent rejection) seawater membrane elements were released. Membrane elements combining productivity of 12,000 gpd and high-salinity rejection are expected in the not-so-distant future.

The newest membrane elements provide flexibility and choice and allow a tradeoff in pressure/power costs. The same water product quality goals can be achieved either by 1) reducing the system footprint/construction costs by designing the system for higher productivity or 2) by reducing the system's overall power demand by using more membrane elements, designing the system at lower flux and recovery, and taking advantage of the newest energy recovery technologies, which further minimize energy use if the system is operated at lower (40 to 45 percent) recoveries.

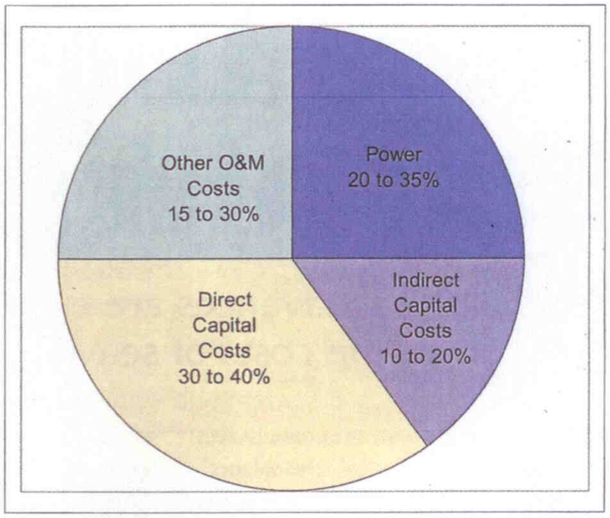


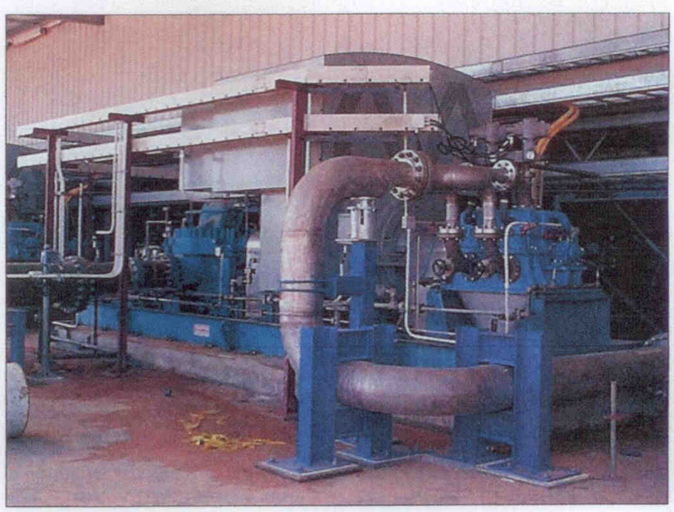
Figure 1. Desalination Cost Breakdown.

Energy is among the largest expenditures associated with seawater desalination. Figure 1 shows a typical breakdown of seawater desalination costs. Advances in the technology and equipment that allow recovery and reuse of the energy applied for seawater desalination have resulted in an 80-percent reduction of the energy used for water production over the last 20 years. Today, the energy needed to produce fresh water from seawater for one household per year (~2,000 kW/yr) is less than that used by the household's refrigerator.

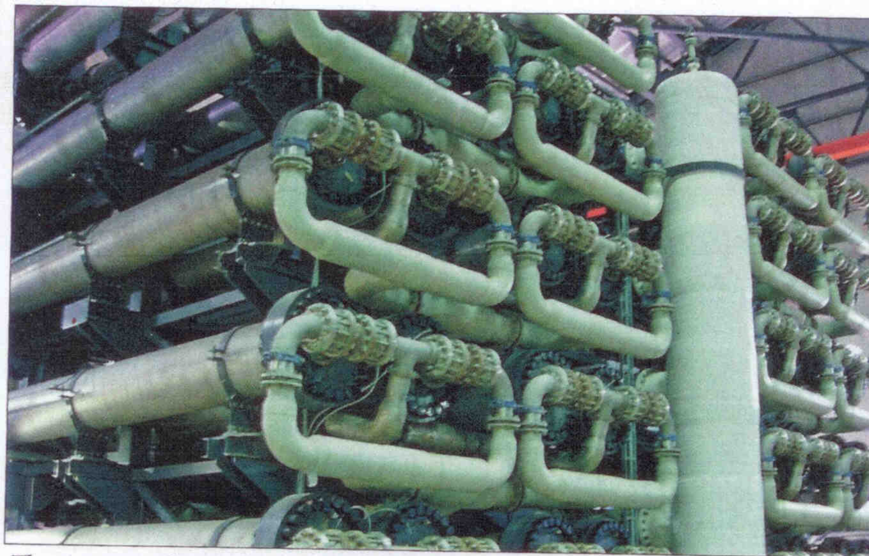
At present, the majority of the existing seawater desalination plants use Pelton Wheel-based technology to recover energy from the SWRO concentrate. The largest Pelton Wheel system in the world is installed at the 36-mgd Point Lisas seawater desalination plant in Trinidad. This power plant uses about 14.4 kWh/1,000 gal of produced fresh water. Pelton Wheel systems allow recovery of 25 to 35 percent of the power initially applied by the SWRO system's feed pumps.

Over the past few years, Pelton Wheel energy recovery systems have begun to give way to a newer, pressure-exchanger based technology. The key feature of this technology is that the energy of the SWRO system concentrate is directly applied to pistons that pump intake seawater into the system. Pressure-exchanger technology typically yields five to 15 percent higher energy recovery savings than Pelton Wheel-based systems. Therefore, pressure exchangers have been installed on most large desalination plants built in the last three years and are planned for some of the largest projects under implementation, such as the 53-mgd Hamma, Algeria, plant and the 37-mgd desalination plant for the City of Perth, Australia. Pressure exchangers are used for practically all large seawater desalination projects built in the last two years.

In 2005, a group of U. S. federal and state agencies, public utilities, and private desalination industry leaders formed the Affordable Desalination Collaboration (ADC, www.affordabledesal.com) team, which is designing a SWRO plant aimed to achieve the lowest possible power demand using state-of-the-art pumping and energy



Largest Pelton Wheel energy recovery system in the world in Trinidad.



The pressure exchanger system of the Ashkelon seawater desalination plant, which currently is the largest system of this type in the world. This plant has broken the energy use barrier of 13.2 kWh/m³ established by previous projects for intake salinity in the range of 38 to 41 ppt.

recovery equipment and the latest membrane technology. The ADC team has installed a pilot SWRO plant at the U. S. Navy's test facility in Pt Hueneme, CA, and operated it for over nine months. The results of this study show that potable water with salinity of less than 500 mg/L can be produced from Pacific Ocean water (salinity concentration of 33,500 mg/L) using less than 10.0 kWh/1,000 gal of energy. The main constraints associated with achieving such low energy use in large-scale desalination plants are the quality of the product water in terms of boron, chlorides, and bromides, and the efficiency of available off-the-shelf pumps and motors used for source water collection, transfer, and feed to the SWRO system. Often, the aforementioned product water quality targets are driven by other more stringent uses, such as irrigation of boron- or chloride-sensitive crops and ornamental plants, rather than by water quality requirements for human consumption. Achieving these goals requires addition of one or more water quality polishing facilities after then main SWRO desalination process, which in turn increases the overall energy consumption for water production.

While the quest to lower energy use is continuing, there are physical limitations to how low the energy demand can go when using reverse osmosis desalination. The main limiting factors are 1) the osmotic pressure that must be overcome to separate the salts from the seawater and 2) the amount of water that could be recovered from a cubic meter of seawater before membrane separation process is hindered by salt scaling on the membrane surface and the service systems. The practical limit for the entire seawater desalination plant and Pacific Ocean seawater is about 6.0 kWh/1,000 gal.

ADC seawater desalination facility in Pt Hueneme, CA.

The Future

Future improvements of SWRO membrane technology are forecast to encompass:

- Development of membranes with higher salt and pathogen rejection and productivity.
- Improvement of membrane resistance to oxidants, elevated temperature, and compaction.
- Extension of membrane useful life beyond ten years.
- Integration of membrane pretreatment, advanced energy recovery, and SWRO systems.
- Integration of brackish and seawater desalination systems.
- Development of new generation of high-efficiency pumps and energy recovery systems for SWRO applications.
- Replacement of key stainless steel desalination plant components with plastic components to increase plant longevity and decrease overall cost of water production.
- Reduction of membrane element costs by complete automation of the entire production and testing process.
- Development of methods for low-cost continuous membrane cleaning to reduce downtime and chemical cleaning costs.
- Development of methods for low-cost membrane concentrate treatment, in-plant and off-site reuse, and disposal.

These technological advances are expected to ascertain the position of SWRO treatment as viable and cost–competitive processes for potable water production and to reduce the cost of desalinated water by 20 percent in the next five years and by up to 50 percent by 2020 GE

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Seawater Desalination: An Emerging Trend in California

By Nikolay Voutchkov

Harvesting fresh water from the Pacific Ocean has been gaining momentum in California over the last five years, as many coastal municipalities and utilities are challenged with population growth pressures, dwindling water supplies, and escalating water production costs. By the year 2030, the state's population is projected to increase from 36.5 to 48 million, which, in turn, would require over 1,000 MGD of new fresh water supplies. Recognizing this water supply demand cannot be met by only relying on traditional water supply sources, conservation and reuse, the California Department of Water Resources (DWR) has charted a new course for exploration of seawater and brackish water desalination as an addition to the state's water portfolio. Currently, there are a number of large seawater desalination projects in various stages of development (see Figure 1).

Currently, Southern California imports 50 percent of its water from two main sources – the Sacramento Bay – San Joaquin River Delta, traditionally known as the "Bay-Delta" and the Colorado River. In order to address the uncertainties associated with the long-term use of imported water from the Bay Delta and Colorado River, a number of Southern California water utilities have charted plans for diversification of their water supply portfolios with seawater desalination. By the year 2020, all Southern California coastal utilities are planning to supply 10 percent to 20 percent of their drinking water from the ocean.

Figure 1. Ongoing Seawater Desalination Projects in California Seawater Desalination in Southern California

Figure 2. Carlsbad Seawater Desalination Project

At present, the 50 MGD Carlsbad and Huntington Beach seawater desalination projects are in the most advanced stage of development (see Figures 2 and 3). Both projects are co-located with coastal power generation plants using seawater for once-through cooling. The two desalination projects are developed as public-private partnerships between Poseidon Resources and local utilities and municipalities.

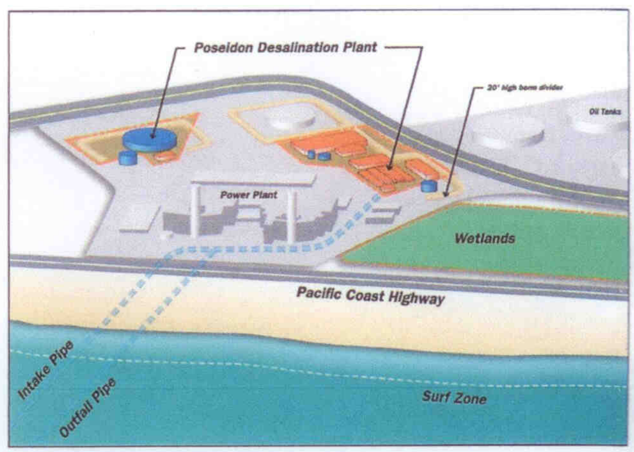

Figure 3. Huntington Beach Seawater Desalination Project

The environmental impact assessments and local land use permits for the Carlsbad and Huntington Beach desalination projects were approved in the first half of 2006. In August, both projects were granted ocean discharge permits for disposal of the high-salinity concentrate generated during the reverse osmosis membrane separation process. These milestone permits clear the way for completion of the project environmental review process by the end of 2006 and for initiating facility construction in 2007. The two projects are targeted to be operational by the end of 2009 and to supply six percent to 10 percent of the drinking water in Orange County and San Diego County. When completed, the two

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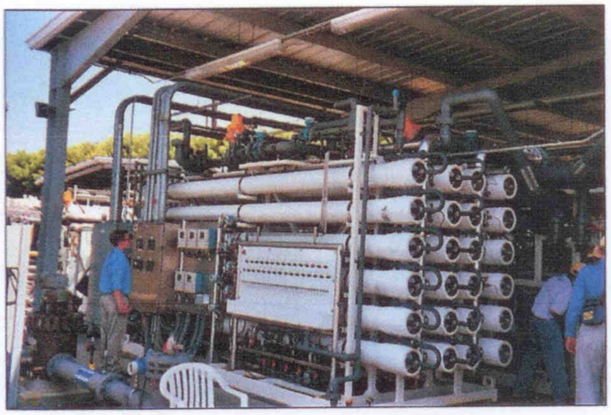

Figure 4. Long Beach Seawater Desalination Demonstration Project

projects will be the largest seawater desalination plants in the western hemisphere.

All Southern California projects shown on Figure 1, with exception of the Huntington Beach and Carlsbad desalination facilities, are at the stage of initial feasibility assessment. The West Basin Water District has been operating a pilot seawater desalination plant over the past several years. The City of Long Beach Water Department is finalizing the commissioning of a seawater desalination demonstration plant which will compare the use of single-stage reverse osmosis and two-stage nanofiltration for seawater desalination (Figure 4).

Seawater Desalination Activities in Northern California

The need for supplemental drought-relief water supplies, groundwater basin overdrafts and associated seawater intrusion, and the measurable ecological impacts of some of the current water supply practices are the main driving forces for the renewed interest in seawater desalination in Northern California. Most of the proposed projects are located in the San Francisco Bay Area and in Monterey County (Figure 1).

Currently, a partnership of San Francisco Bay Area water districts (Contra Costa Water District, Easy Bay Municipal Water District (EBMUD), Santa Clara Valley Water District and the San Francisco Municipal Utility District) are studying the feasibility of several seawater desalination plant locations – one in San Rafael in partnership with the Marin Municipal Water District (MMWD), one in Oakland, and one at the Mirant Power Plant in Pittsburg, Contra Costa County. A fourth location is also considered – a site near Ocean Beach on the Pacific Ocean. If construction of seawater desalination plants is found viable, this initiative may yield one to three seawater desalination plants with a total production capacity of 20 to 80 MGD within the next five years.

EBMUD is developing another seawater desalination facility, which is planned to be co-located with the C&H Sugar food processing plant in Crockett. This facility would use up to 3 MGD of cooling water from the food processing plant to produce 1.5 MGD of desalinated water which will be applied for industrial uses. The desalinated water would replace the drinking water the refinery currently receives from EBMUD. The concentrate from the desalination plant will be discharged through the existing wastewater outfall of the C&H Sugar plant.

The Marin Municipal Water District is also developing a large seawater desalination project in the San Francisco Bay area. This project is targeted to produce between 10 MGD and 15 MGD of desalinated water and to provide reliable, drought-proof alternative to the construction of a new pipeline for supplemental water supply from the already over-allocated Russian River. Marin Municipal Water District has recently completed a 12-month desalination pilot test and is well under way with the preparation of environmental impact assessment for this project. A draft environmental impact report is expected to be circulated for public review by the end of 2006.

Monterey County, located south of the San Francisco Bay Area, is currently the grounds for the development of several new seawater desalination projects. Two large competing projects are proposed at Moss Landing. The first project is a regional seawater desalination facility planned to be delivered under a public-private partnership between Pajaro-Sunny Mesa Community Services District and Poseidon Resources. The regional desalination plant would be located at a former National Refractories industrial plant site, which is adjacent to the Moss Landing Power Generation Station (Figure 5). This desalination project would use the existing National Refractories open intake and ocean outfall. Alternatively, the project developers are considering to supply warm cooling seawater to the desalination plant from the Moss Landing Power Generation Station, when available, in order to reduce impingement and entrainment of marine organisms and to minimize the amount of power used for reverse osmosis separation.

Figure 5. Moss Landing Regional Seawater Desalination Project

Most of the potable and irrigation water used in Monterey County comes from a coastal aquifer, which has been steadily increasing in salinity due to over-pumping. The main purpose of the regional seawater desalination

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project proposed by the Poseidon/Pajaro-Sunny Mesa team is to replace the use of groundwater from the coastal aquifer with desalinated seawater and thereby to minimize further seawater intrusion.

The California American Company (Cal-Am) is developing a smaller, 12 MGD project at the Moss Lending Power Generation Station site and proposes to use the power station's cooling water discharge as an intake and discharge of the desalination plant. The main purpose of this project is to offset the environmentally damaging diversion of large volumes of fresh water from Carmel River, which currently is used as a main source of water supply to the Cal-Am's customers in the southern part of the county. Although this project is developed in a parallel track with the Pajaro-Sunny Mesa/Poseidon desalination project, most likely only one of the two projects will be built. The regional desalination project proposed by Pajaro-Sunny Mesa/Poseidon is designed to accommodate Cal-Am's water demand.

Besides the several large projects described above, there are a large number of other smaller projects under development in Northern California (see Figure 2, page 24). Most of these projects are in early phases of feasibility and environmental studies, and are not expected to yield full-scale desalination plants before 2010.

Concluding Remarks

Within the next five to 10 years, many Californian coastal communities are planning to make seawater desalination a permanent part of their water supply portfolio. More than 20 seawater desalination plants supplying up to 10 percent of California's total water demand are projected to be built by the year 2020. Although existing fresh water sources, conservation and reuse would continue to play a central role in the state's long-term water supply strategy, seawater desalination has unique appeal to many coastal communities because it allows access a reliable and drought-proof source of drinking water that can be developed and controlled locally. ■

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Desalination: One Way the Lone Star State Will Beef Up Its Water Supply

By Peter Hildebrandt

The old expression "big like Texas" easily applies when it comes to diversity in water needs. Texas has regions with typical southeastern US rainfall totals in the eastern part of the state, as well as places where the rainfall is a scant 8 inches—more in line with those of Las Vegas or Tucson.

> IT SHOULD COME AS NO SURPRISE THAT CERTAIN AREAS OF TEXAS ARE LOOKING SERIOUSLY AT DESALINATION TO MEET DEMAND. ONE LOCATION IS EVEN MOVING TOWARD ITS FIRST PILOT FOR A LARGE-SCALE SEAWATER DESALINATION PLANT.

Recent Changes in the Way Texas Does Water Planning

In 1997 the State of Texas enacted a law, SB-1, which revamped the way water planning is conducted in the state. Charged with seeing through the implementation of SB-1, the Texas Water Development Board divided the state into 16 regional water planning groups operating on a five-year cycle. The second of these cycles has just finished.

The regions are designed, more or less, to conform to river basins or boundaries of underground water sources. The law also specifies the various stakeholders that must be represented on each of the 11 regional planning groups. These groups include agriculture, small businesses, large businesses, steam-electric generation, and river authorities, among others.

The groups get state funds to pay for consultants to develop water demand projections, available supplies, needs, and strategies for filling those needs. The law also specifies that any water projects that come to the state for financing through the water development board or for permits through the Texas Commission on Environmental Protection must be consistent with the regional plan. "There are some teeth in there to make sure, if you have a project you are thinking about, that it's in the regional water plan," says Linda Fernandez, principal with Fernandez Group Inc., which specializes in public outreach and public relations on water issues.

"The second round of planning has just been completed and the 16 groups submitted their regional water plans to the board; the board has reviewed them and now they are combining them into a statewide plan.

"Based on recommendations or concerns from the regional plans," Fernandez continues, "the Water Development Board will compose a list of suggested legislative actions for the next session of the Texas Legislature starting in January. This whole planning process has really brought water to the forefront in terms of public awareness and the fact that the different stakeholders need to work together to coordinate what they're doing; the time is right for all of these things to be happening."

Sources of water previously considered unusable are now receiving further scrutiny, according to Fernandez. Those sources of water range from the Gulf of Mexico and brackish groundwater to water high in total dissolved solids or other substances. "Because we have a booming population with increasing demands, and because our climates and rainfall vary greatly—from 60 inches per year in the eastern section to 8 inches in the western parts—there is much activity going on in this area," says Fernandez.

"There's definitely a push in this direction in south Texas, which seems to be the big growth area of the state for trying out new and innovative technology and new approaches for extending water supplies, not just for municipal uses but also for agricultural uses. One area for greater scrutiny in water efficiency is in the area of water for agricultural uses. Perhaps greater than 75% of water use now goes for agricultural uses, but due to population growth and because the value of water is increasing, that proportion should decline to less than 50%.

"This is one big area where you can see a tremendous return on investment, greater than you would see putting similar funds into the municipal side."

Fernandez says south Texas seems to be a leader in innovative technology because it's in a situation in which the water supply is finite. The surface water from the Rio Grande has been the source of water for all uses. But it is also shared with Mexico.

"Mexico accrued a tremendous debt, though, and did not allow inflows into the Rio Grande," says Fernandez. "That caused a lot of agricultural suffering for several years. As a result of the recent drought, the Mexican water debt issue and the rapid pace of urbanization in south Texas have led to the

All photos: Fernandez Group Inc.

A panel at the SRWA brackish groundwater desalination facility question of how we will extend our water supply."

Using Ocean Water

Several years ago Texas Governor Rick Perry announced an initiative to explore using the Gulf as an uninterruptible drought-proof supply. The Texas Water Development Board, the state agency charged with developing water supply, was tasked with putting out a request for proposal. Three sites were selected for a feasibility analysis: Brownsville, Corpus Christi, and Freeport. After a two-year period, results were turned in to the Texas Water Development Board.

Then the three sites were all invited to submit proposals for pilot studies. Based on the feasibility analyses, Brownsville clearly was the site ready to go forward.

In early 2006 Brownsville Public Utility Board was awarded $1.34 million from State of Texas funding for the pilot desalination plant. The city is also contributing $500,000 in cash and another $600,000 in in-kind services. NRS Consulting Engineers, a Texas-based firm, is the lead engineer and consultant on the pilot study. The goal of the pilot study is to have results by August 2006.

NRS is doing two seawater desalination pilot plants, one at the Port of Brownsville, taking water from the port channel, and the other on South Padre Island. "These are scaled-down versions–one-hundredth the size–of the plants that will contain all the elements of the larger facilities," says Bill Norris, an engineer with NRS.

During the course of testing at the pilot plant, NRS will look at four different membranes, finally narrowing it down to two. "To decide which membrane to go with we will look at effi-

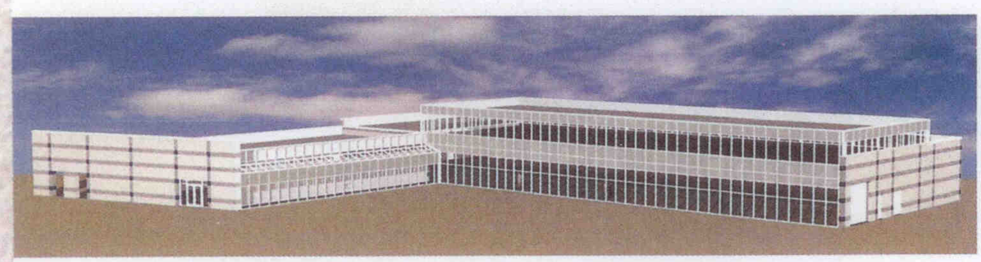
Fernandez desal plant site

ciencies, pressures, and how well they perform in general," says Norris.

The membranes themselves are 8 inches in diameter and are simply slid into the vessels. The membranes last an average of five years before they must be replaced. "Probably after five years, when you go to replace them, the technology is going to improve enough that maybe the pressure will be reduced," says Norris. "This is what we've seen in the past."

Typically the membranes will cost several hundred dollars for a series of membranes within the vessels. But by the time you multiply how many membranes are being used in the system, for the 7.5 million gallons being processed daily, that can add up to a half-million dollars' worth of membranes being used.

"But perhaps the biggest challenge is environmental," says Norris. "The salt content of seawater just makes it more corrosive in nature; plus you have barnacles to contend with. We don't have the ground to filter things out like we would on a brackish water project. Here it is just the seawater coming in from an ocean intake. This adds a lot of costs to the project as well."



An illustration of the El Paso facility

Making Brackish Water Work

Brackish groundwater has recently turned into another big solution. Brackish water is defined as water that is 3,000 parts per million (ppm) for sodium, which exceeds drinking-water standards and means that it must be treated. (Seawater, by contrast, is 30,000 ppm for sodium, though seawater's benefit is that it's an uninterruptible source of water during drought.)

Since the salinity levels for brackish groundwater are so much lower than those of seawater, there are not the same kinds of costs involved. "The biggest expense with seawater comes with the energy required to force the water through the membranes," says Fernandez. "Dubai now has the largest desalination plant in the world going up and other places such as Spain are very involved with this type of seawater desalination membrane technology."

Because groundwater in the south Texas region was brackish and unsuitable for any use, it remained untapped. Much of this drive to use brackish groundwater has come from the rise in the cost of using surface water. Ten years ago, surface-water rights went for approximately $400 per acre foot; they now go for $2,000 per acre-foot.

"The technology for making brackish groundwater usable was simply too expensive; it was therefore not a viable option," says Fernandez. "What's happened now is that the cost of the membrane technology has gone down, just like the cost of computers dropped over the years. Also, since the cost of surface rights has soared, the two lines of the graph of economic viability have finally intersected."

Brownsville Boosts Supplies With Brackish Water Desalination

Brownsville PUB is a partner in the Southmost Regional Water Authority

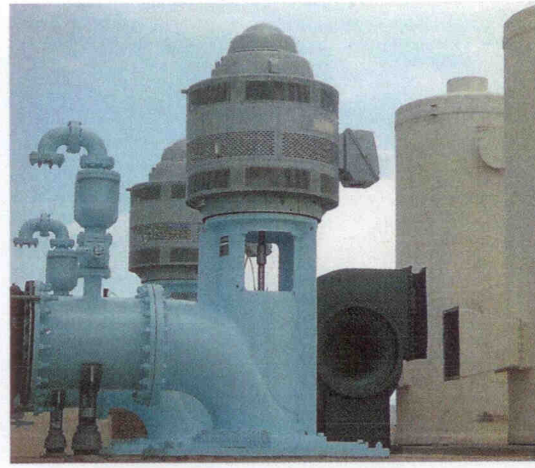
(SRWA) in south Texas. Two years ago the SRWA built the largest brackish groundwater desalination facility in Texas. That facility has an output of 7.5 million gallons per day. NRS was also involved in the design and construction of that facility. "It just made more economical sense to have a regional facility so that everyone wasn't building their own little plant," says Fernandez. "Things are working out great with this facility; the plant is also easily expandable. As time goes by and water demand increases, that's an important consideration."

NRS is now at work on its sixth brackish water desalination plant in south Texas. Its third such plant should be up and running soon, and two others are out for bids and, at the time of this writing, were expected to have construction start in the latter part of 2006. "NRS started looking at brackish water desalination about 20 years ago," says Norris.

"Our first plant was not a brackish plant but a wastewater plant. We took the technology and applied it to wastewater at a Fruit of the Loom plant to create bottle-quality water. This was at the time one of the largest water reuse plants of its kind in the world. The plant has since shut down due to 'off-shoring.'"

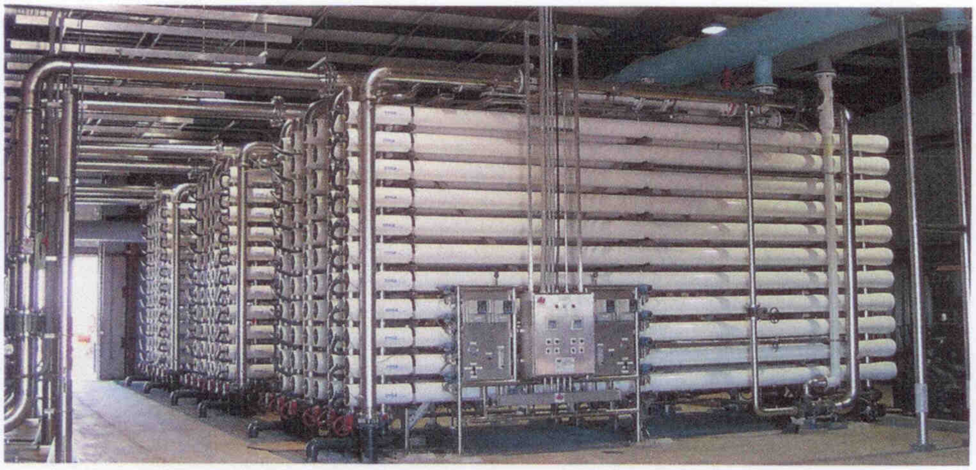
In 1995 NRS designed and constructed a small brackish water desalination plant, 125,000 gallons per day, in Laredo, TX. Rancho Viejo or Valley Municipal Utility District was then the first plant in the valley that at 250,000 gallons per day provided 30% to 40% of its water needs for a resort in the area. That started up in 1999.

"These projects spurred much interest locally," says Norris, "the thinking being, 'We can treat this water pretty reasonably.' In 2000 and 2001 interest in the SRWA became strong and the feasibility of doing a regional plan was studied; in 2004 the largest brackish water desalination plant in Texas was constructed in Brownsville, treating 7.5 million gallons per day. Until El Paso is built we will remain the largest."



SRWA pump ... Texas-sized

The plant operates 24/7 and now provides approximately 40% of the water supply for Brownsville, a city with a population between 150,000 and 200,000. It is also one of the fastest growing areas of the US. "What has driven this whole push toward brackish water desalination is the cost of buying the rights for the water



The SRWA desalination facility has an output of 7.5 million gallons per day.

from out of the river," says Norris. "At $2,000 per acre-foot I can build a plant for just the cost of the raw water alone. That makes the whole thing feasible along with the fact that I can build a groundwater treatment plant cheaper than I can build a surface-water treatment plant, though the operation costs for a groundwater treatment plant are somewhat higher."

The wells draw brackish water up with 12-inch-diameter pipes from depths of anywhere from 300 to 1,000 feet. In certain areas closer to the coast, the water is not as useful, as the water becomes too saline.

"We now know enough about this process that we can account for the degree of corrosiveness of the water when it comes to our piping," says Norris. "We install a large amount of fiberglass or high-grade stainless steel piping; even our well casings are fiberglass."

Brownsville has 20 brackish water wells in a distribution network similar to a natural gas pipeline network. A 30-inch pipeline comes into the plant and goes directly into a cartridge filter. This filters out any of the few suspended solids that might be contained in the water. The next step is the high-pressure pump, which pumps at 160 pounds per square inch through the membrane treatment system.

From that point the water goes into a storage tank where the pH is adjusted back to being a bit more acidic so some of the particles do not precipitate out onto the membranes. The water is eventually neutralized back before being distributed into a concrete storage tank and pump station.

Brownsville Public Utility District provides all of its own power for its brackish water desalination plant. This is competitive with rates in other cities in the state.

"Our biggest challenge with the plants is making sure that we are optimizing the performance all the time," says Norris. "We have good operators that run the Southmost plant. We really don't have many challenges, but then again, maintenance is an ongoing challenge."

The challenge in getting these plants built has a lot to do with the discharge of the concentrate. Being close to the Gulf Coast makes it less of a problem when it comes to discharging the sodium that is generated.

"Challenges with the seawater plant are much greater," says Norris. "The water has a much higher salt concentration there, and there are much more details to deal with from that as well as the higher pressure generated by the higher salt content. For brackish water the pressure used in pumping must have 160 pounds per square inch, while seawater takes a pressure closer to 900 pounds per square inch for pumping."

Outside the SRWA desalination facility

El Paso's Desalination Solution

El Paso is now hard at work building a brackish water desalination facility as well, which will be the largest desalination facility in Texas as well as one of the largest in the United States. It will supply between 25 million and 30 million gallons per day when it comes online, according to Fernandez.

El Paso is totally dependent on groundwater supplies. "Their freshwater aquifer is sinking rapidly," says Fernandez. "That and the fact that they receive 8 inches or less in rainfall each year makes a second look at brackish groundwater supplies feasible. There are plenty of supplies of such water in the area."

El Paso has one plant completed and one that is under construction. The completed plant makes use of several brackish groundwater wells in the Mission Valley section of the city. The wells went brackish a number of years ago, so since they are already hooked up to the distribution system the solution identified to get those wells back online was to construct new well heads.

"Those wells now produce 8 million gallons per day for the City of El Paso," says Bill Hutchinson, El Paso water resources manager. "In addition to those we are constructing a big plant that is approximately one year away from completion. It is a 27.5-million-gallon-per-day plant that will take brackish water from the Hueco Bolson, the region's aquifer. Our plant will then be the biggest in the state, and from what I've heard, the largest inland brackish water treatment plant in the world."

The water from the plant will be treated through reverse osmosis before it's delivered into the system. But at the same time it will generate approximately 3 million gallons per day of concentrate that will be disposed of in deep injection wells roughly 22 miles from the plant.

"Currently we're pumping about 40,000 acre-feet per year out of the Hueco Bolson aquifer, which is the groundwater basin on the east side," says Hutchinson. "We have three sources of water in El Paso, the Hueco Bolson, the Mesilla Bolson, and the Rio Grande."

The Hueco produces one-third or less of El Paso's total water supply in a normal year, when there is water in the river. "If this new plant were to be run at basically 100% it would represent slightly over 30,000 acre-feet of pumping; depending upon the year, 65% to 75% of groundwater pumped in the Hueco will be run through our new desal plant.

"This won't be our one and only source," says Hutchinson. "This is just part of our diverse portfolio of water sources, which is what we are trying to manage: resources that are somewhat redundant so we can take care of things during a drought under a conjunctive use management plan, as well as diversify things as far as brackish water, fresh water, reuse, and all the other various components."

By locating and pumping the wells in this new manner, El Paso will have the opportunity to isolate the two sources, brackish and fresh water. For years the city has struggled with the problem of having a well start drawing brackish water after awhile.

"The idea here is to create a barrier," says Hutchinson. "Once that's done we can intersect the brackish water, pump it, treat it, and then preserve the fresh water for use during drought years when the rivers aren't running very well. We are already facing that scenario this year, and certainly for next year it looks like it's going to be tough as well."

The biggest contrasts in the desalination projects of El Paso and those in the Brownsville area come in the area of concentrate disposal. When it comes to the concentrate, the cities near the coast have a large body of water they're able to deposit that into. "That is the biggest challenge from our point of view," says Hutchinson. "For an inland plant the big question is, 'What do you do with the byproduct of the treatment process, the concentrate?' We recently had a two-day technical conference in our area devoted primarily to how to manage concentrate from desal processes."

Membrane Technology May Hold the Key

With the more stringent water-quality rules enacted by the EPA, such as treating for viruses, cryptosporidiosis, giardiasis, and others, Linda Fernandez feels that this makes the membrane technology the most effective to use. "The entire membrane filtration business has been really booming, resulting in the formation of the South Central Desalting Association [SCDA]," says Fernandez.

As growing numbers of membrane plants come online and are so different from conventional treatment plants, using chlorine and other additives, there is an acute need for training geared to operators running such plants. "Though the costs for the membranes have dropped and they are somewhat competitive, it's still fairly expensive technology and it's easy to 'kill' them if you are not careful," says Fernandez. "SCDA has been active in training membrane operators and doing technology transfer. I think membrane technology is an important link in meeting the region's growing water needs." **we**

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